ET 47 - Electrician Theory Examination Marking Schedule

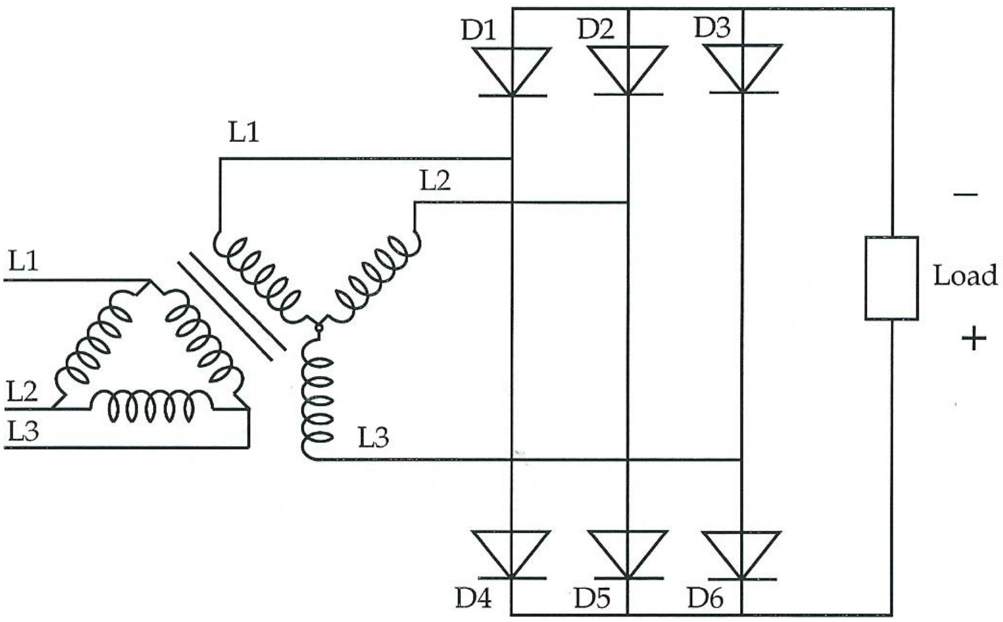
Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the accepted answers to the examination questions. A marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

Question 1	*Reference Marks*	*Marking notes*
(a) (i) The synchronous motor rotates at a constant speed independent of the load. (ii) ● Any ONE of: * Reduced starting current * Reduced voltage fluctuation ● Limiting mechanical shock	(1 mark) (½ mark) (½ mark)	
(b) (i) A tap-changer is used to maintain the voltage. (ii) It is the total VA load that can be imposed on a CT.	(1 mark) (1 mark)	
(c) Any TWO of: ● A capacitor in series with the auxiliary winding ● Different winding impedances ● A shaded pole	(2 marks)	
(d) Any TWO of: ● Snubber circuit ● MOV (surge diverter) ● Free-wheeling diode ● RC circuit ● Optocoupler/Relay ● UPS	(2 marks)	
(e) Any TWO of: ● Type of conductor material ● Cross-sectional area ● Load ● Length of cable	(2 marks)	
(f) Any ONE of: ● * The motor speed reduces * The current rises until the overloads operate	(2 marks)	

Question 1	*Reference Marks*	*Marking notes*
● * The torque is proportional to the square of the voltage * So a drop in voltage reduces the motor speed		
(g) Any ONE of: ● The breaking capacity of the MCBs is too low for the PSSC of the installation. ● The PSSC level of the installation has increased.	(2 marks)	
(h) The motor would stall and burn out.	(2 marks)	
(i) ● To verify that the PRCD operates within specified residual current limits. ● To verify that the PRCD operates within specified time limits	(1 mark) (1 mark)	
(j) (i) Any ONE of: ● Shock hazard due to HV pulses from the igniter (typically 4 kV to 10 kV) ● Damage could occur to the meter if measurement is made during start-up. (ii) Any ONE of: ● Injury from glass shards ● Inhalation of phosphors contaminated with mercury (iii) Any ONE of: ● Fire risk (sodium + moisture produces hydrogen) ● Risk of chemical burns (sodium + water produces sodium hydroxide (caustic soda)) (iv) Any ONE of: ● Skin burns from shortwave ultra-violet radiation. ● Eye inflammation from shortwave ultra-violet radiation. ● Exposed filaments are a shock hazard	(½ mark) (½ mark) (½ mark) (½ mark)	

Question 2	*Reference Marks*	*Marking notes*
(a) (i) • To verify that the fault loop impedance of the socket outlet final subcircuit is low enough.	(1 mark)	
• To ensure the HRC fuse will operate in 0.4 S	(1 mark)	
(ii) • To ensure the HRC fuse breaking capacity is rated to safely interrupt.	(1 mark)	
• The PSSC flowing under fault conditions.	(1 mark)	
(b) (i) • The thermal overload device would operate within 1 to 2 minutes.	(1 mark)	
(ii) The HRC fuse would operate in 0.2 S	(1 mark)	
(iii) As the magnitude of the fault current rises, the time taken for the fuse to operates decreases rapidly.	(2 marks)	
(c) • The protective device closest to the fault operates	(1 mark)	
• Before any other protective device can operate	(1 mark)	

Question 3	*Reference Marks*	*Marking notes*
(a) (i)  D1 D2 D3 L1 L2 L1 L2 L3 L3 – Load + D4 D5 D6		The answer does not need to include the transformer
● Correct incoming supply	(½ mark)	
● Correctly connected diodes	(3 mark)	
● Correctly connected load	(½ mark)	
● Correct load polarity	(½ mark)	
● Working circuit	(1 mark)	
(ii) 300 Hz	(½ mark)	
(iii) Any TWO of: ● Capacitor ● Inductor ● Resistor	(1 mark)	

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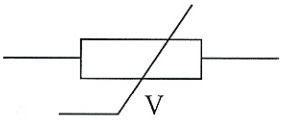
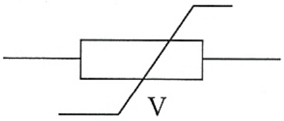
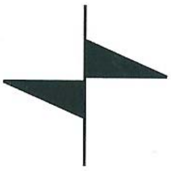
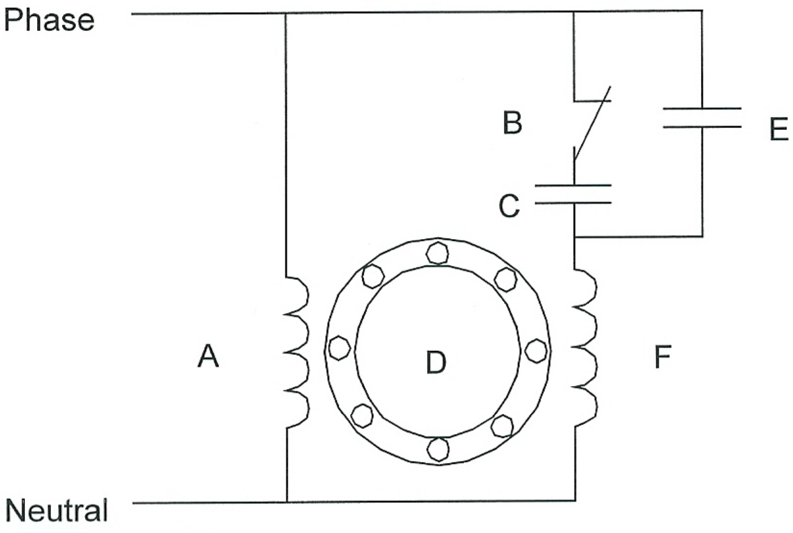
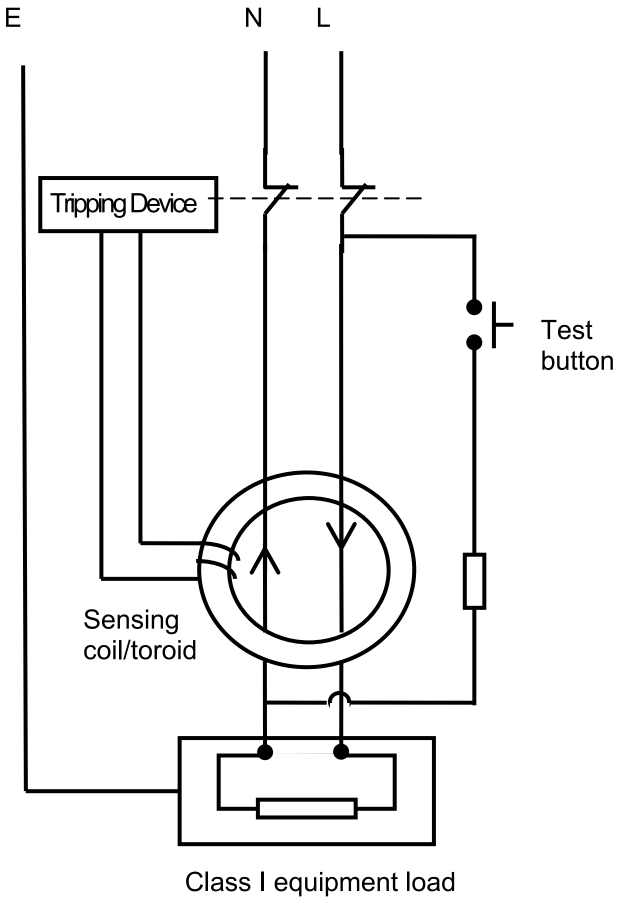
Question 3	*Reference Marks*	*Marking notes*
(b) (i) Any ONE of:   	(1 mark)	
(ii) To protect voltage sensitive equipment from spike (voltage transients).	(½ mark)	
(iii) ● The VDR resistance drops to a very low resistance when a spike appears across it.	(½ mark)	
● It protects the equipment by shorting the spike the instant it appears across the VDR terminals.	(½ mark)	
(iv) In parallel with the supply to the equipment being protected.	(½ mark)	

Question 4	*Reference Marks*	*Marking notes*
(a) $N_S = \frac{N_P \times 1}{20}$	(½ mark)	
$= \frac{2000 \times 1}{20}$	(½ mark)	
$= 100$ turns	(1 mark)	
(b) $V_S = \frac{N_S \times V_P}{N_P}$	(½ mark)	
$= \frac{100 \times 230}{2000}$	(½ mark)	
$= 11.5\text{V}$	(1 mark)	
(c) Volts per turn $= \frac{V}{N}$	(½ mark)	
$= \frac{230}{2000}$	(½ mark)	
$= 0.115$ volts per turn	(½ mark)	
(d) $VA = V \times I$	(½ mark)	
$= 230 \times 2$	(½ mark)	
$= 460$ VA	(½ mark)	
(e) (i) The secondary is isolated from the supply.	(1 mark)	
(ii) ● There is a physical connection between the primary and secondary windings	(1 mark)	
● Under fault conditions or incorrect connections, dangerous voltages can appear on the secondary.	(1 mark)	

Question 5	*Reference Marks*	*Marking notes*
(a) In star		Award all marks if it is only shown that the delta connection method is incorrect
$I_{PH} = \frac{V_{PH}}{R_{PH}}$	(½ mark)	
$= \frac{230}{30}$	(½ mark)	
$= 7.67A$	(½ mark)	
$I_{PH} = I_L$	(½ mark)	
In delta		
$I_{PH} = \frac{V_{PH}}{R_{PH}}$	(½ mark)	
$= \frac{400}{30}$	(½ mark)	
$= 13.33A$	(½ mark)	
$I = I_{PH} \times \sqrt{3}$	(½ mark)	
$= 13.33 \times \sqrt{3}$	(½ mark)	
$= 23.1A$	(½ mark)	
The current drawn by the delta connection method is too large for the protection	(½ mark)	
(b) $P = V_L \times I_L \times \sqrt{3} \times pf$	(½ mark)	
$= 400 \times 7.67 \times \sqrt{3} \times 1$	(½ mark)	
$= 5313.78W$	(1 mark)	
(c) (i) Replace the rewireable fuses with 25A MCBs or 25A HRC fuses	(1 mark)	Higher rated rewireable fuses cannot be used
(ii) $P = V_L \times I_L \times \sqrt{3} \times pf$		
$= 400 \times 23.1 \times \sqrt{3} \times 1$	(½ mark)	
$= 16003.68W$	(1 mark)	

Question 6	*Reference Marks*	*Marking notes*
(a) 		
• Correctly connected main winding (A)	(½ mark)	
• Correctly connected centrifugal switch (B)	(½ mark)	
• Correctly connected start capacitor (C)	(½ mark)	
• Correctly connected run capacitor (E)	(1 mark)	
• Correctly connected auxiliary winding (F)	(½ mark)	
• Working circuit	(1 mark)	
(b) • At start, additional capacitance is connected in series with the auxiliary winding	(1 mark)	
• This provides the maximum phase displacement between winding currents to produce maximum torque.	(2 marks)	
• When the rotor reaches 75% full speed the centrifugal switch opens and disconnects the start capacitor.	(1 mark)	
• The run capacitor ensures there is a phase displacement between the winding currents providing a high running torque.	(1 mark)	
(c) It produces less vibration and noise	(1 mark)	

Question 7	*Reference Marks*	*Marking notes*
(a) ● Earth continuity test ● Insulation resistance test ● Motor winding test ● Correct circuit connections test	(½ mark) (½ mark) (½ mark) (½ mark)	
(b) Earth continuity test		
● Ohmmeter	(½ mark)	
● Test between the unconnected end of the final subcircuit cable and the frame of the motor	(1 mark)	
● A test result of 1Ω or less	(½ mark)	
Insulation resistance test		
● Insulation resistance tester	(½ mark)	
● 500V d.c.	(½ mark)	
● With the isolation switch on	(½ mark)	
● Test between the phases and earth at the unconnected end of the final subcircuit cable.	(1 mark)	
● Test between the phases and earth at the load side of the DOL starter.	(1 mark)	
● Test results of 1 MΩ or more	(½ mark)	
Motor winding test		
● Ohmmeter	(½ mark)	
● Measure the resistance of each winding.	(1 mark)	
● The resistance of each winding should be the same or similar.	(½ mark)	

Question 8	*Reference Marks*	*Marking notes*
(a)  E N L Tripping Device Test button Sensing coil/toroid Class I equipment load		No marks can be awarded for part (a) if there is no earth connection
• Correctly connected test circuit and resistance	(1 mark)	
• Correctly connected sensing coil/toroid	(1 mark)	
• Correctly connected phase, neutral and earth.	(1 mark)	
• Correctly connected tripping circuit	(1 mark)	
(b) (i) 30 milliamps.	(½ mark)	
(ii) 10 milliamps	(½ mark)	
(iii) 300 milliamps.	(½ mark)	
(c) Because Type AC RCDs do not have a residual pulsating d.c. function	(1 mark)	
(d) (i) Yes	(½ mark)	
The RCD detects the imbalance regardless of the polarity of the supply.	(½ mark)	

Question 8			*Reference Marks*	*Marking notes*
	(ii)	Yes	(½ mark)	
		The RCD would detect and imbalance between the phase and neutral currents.	(½ mark)	
(e)	PRCD	Portable Residual Current Device.	(½ mark)	
	RCBO	Residual Circuit Breaker with Overcurrent protection	(½ mark)	
	SRCD	Socket Residual Current Device	(½ mark)	

Question 9	*Marks*	*Reference*	*Marking notes*
(a) Any TWO of: ● Limits the voltage to 230V to earth under fault conditions. ● Limits the voltage between neutral and earth to about 0V. ● Ensures that under fault conditions, the voltage between any earthed metal and the mass of earth never rises above (about) 0V	(2 marks)		
(b) MVA = $\sqrt{3} \times V_L \times I_L$ $I_L = \frac{MVA}{\sqrt{3} \times V_L}$ $= \frac{20 \times 10^6}{\sqrt{3} \times 400}$ = 28.87 kA	(½ mark) (½ mark) (1 mark)		
(c) ● Under fault conditions ● The voltage that appears on the metal frame never rises above (about) 0V ● Because the resistance of the earthing conductor does not exceed 1Ω	(1 mark) (1 mark) (1 mark)		
(d) Any TWO of: ● Capacity of the supply source ● Transformer impedance. ● Circuit impedance or length of cable run or distance from the transformer to the switchboard	(2 marks)		
(e) Any ONE of: ● There is supplementary insulation between the basic insulation and any metal that could become live under fault conditions. ● Under fault conditions it is more likely that a PEC would liven the frame of the appliance rather than the insulation breaking down	(1 mark)		